Title: Solid-fluid transition in earthflows: understanding processes for predicting landslide mobility and magnitude

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Research program

Earthflows occur in many hilly and mountainous areas of the world and are pervasive in many rapidly eroding landscapes. Although their evolution is often characterized by slow intermittent movement controlled by pore pressure fluctuation at the landslide base, under specific conditions, unexpected accelerations might occur promoting catastrophic slope failure through landslide material fluidization (i.e. surging events). Such events can result in extensive damage to settlements and claim human lives. A number of studies have identified the association of hydrologic forcing (i.e. prolonged and/or intense rainfall), the loss of drainage pathways due to landslide deformation, and the availability of new mobilized sediments in the source area as potential concurring factors promoting this behavioral transition. In some cases, undrained loading of the landslide head, caused by retrogression of the upper flow boundary, has been recognized as a triggering factor for a surging reactivation that propagates along the earth flow through partial or complete material fluidization. In this context, a common feature of such landslides is the presence of a significant fraction of fine-grained (i.e. clay) materials that can control the rheology of the system and available resistance along the sliding surface. A recent study, identifying material viscosity as a diagnostic parameter of solid-fluid transition in landslides, has shown that clayey soils originated in flow-like landslides can exhibit a yield-stress fluid behavior associated with a bifurcation in viscosity and water content deviation from the Atterberg liquid limit might control mechanics of the system at solid-fluid transition. In addition, a significant drop in shear wave velocity has been identified to be associated to earthflow mobilization, indicating a significant increase of porosity and consequently water content that might control the solid-fluid transition. On this basis, although the interest of researchers to this theme is growing, the process of transition between sliding (solid) to flowing (fluid) mechanisms is not fully understood, also in terms of boundary conditions, and it is still not clear how to predict landslide mobility and magnitude associated to this behavioral transition. In this perspective, further contributions, taking into account both the mineralogical, geotechnical and rheological properties of landslide materials, as well as landslide geometry and deformational patters, are needed to contribute to a better understanding of the process behind such phenomenological transition and related triggering conditions, and predicting consequent landslide mobility and magnitude change.

Proposal for a PhD position

The Department of Earth, Environmental, and Resources Sciences at the University of Naples, Federico II invites applications for one PhD position in the context of the research program described above. The potential PhD research project will be aimed at contributing to a better understanding of conditions promoting slide to flow transition in earthflows: i) elucidating the mineralogical, geotechnical and rheological properties of landslide material that make such landslides susceptible to behavioral transitions, ii) identifying triggering conditions and factors as well as and process evolution, and iii) testing modeling tools for magnitude and mobility predictions. In this perspective, the project will use data from literature analysis, field surveys, field and satellite monitoring, laboratory testing and numerical modeling.

The project will be consistently organized in multiple subsequent phases:
i) literature analysis (2 months), ii) sites identification and sampling (3 months), iii) mineralogical analysis (5 months), iv) geotechnical analysis (5 months), v) rheological analysis (5 months), vi) constitutive relation testing (6 months), vii) modeling approach definition in mobility and magnitude prediction perspective (6 months), viii) PhD thesis preparation (4 months).

Potential study areas will be identified along the Apennine ranges of both southern and northern Italy, southeastern France, and western United States.

The candidate expenses for field and other activities related to the PhD project will be covered by the Engineering Geology and Geotechnics Group Departmental funds. The candidate is expected to have solid background in physics and a general knowledge of informatics. Knowledge of programming techniques is desirable. The candidate is expected to complete a training/research period at a foreign institution.